

## TRACI-XL, the test cooling system for the CBM Silicon Tracking System\*

*J. Sánchez<sup>1</sup>, J. M. Heuser<sup>1</sup>, C. J. Schmidt<sup>1</sup>, P. Petagna<sup>2</sup>, B. Verlaet<sup>2</sup>, L. Zwalinski<sup>2</sup>, and H. R. Schmidt<sup>3</sup>*

<sup>1</sup>GSI, Darmstadt, Germany; <sup>2</sup>CERN, Geneva, Switzerland; <sup>3</sup>Eberhard Karls University, Tübingen, Germany

An evaporative bi-phase cooling system based on CO<sub>2</sub> has been chosen as the best option to extract the heat produced by the read-out electronics in the CBM Silicon Tracking System. In the framework of the EU-FP7 project CRISP, the system TRACI (Transportable Refrigeration Apparatus for CO<sub>2</sub> Investigation), developed at NIKHEF/CERN to provide support to the ATLAS and LHCb experiments, is being upgraded at GSI from 100 W to 1 kW cooling power. This system TRACI-XL will be used as a testing device for the CBM application.

### I-2PACL concept applied to TRACI-XL

The I-2PACL principle (Integrated 2 Phase Accumulator Controlled Loop) was created as simplification of the 2PACL systems by using the CO<sub>2</sub> line to condensate the gas inside the accumulator instead of using a branched line derived from the condensing unit. Therefore the control is reduced to one cartridge heater controlled by PLC Siemens Simatic S7-1200. The size of the control unit is decreased and it allows a wider range of possible operating temperatures from -30° C up to room temperature.

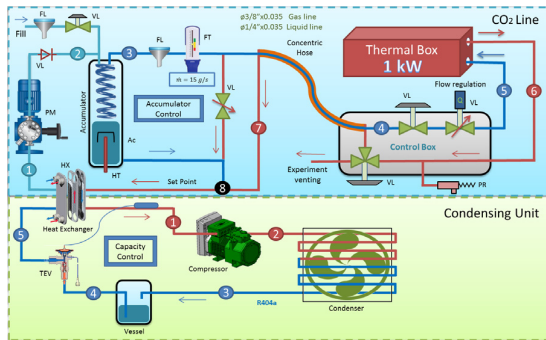


Figure 1: Process diagram of TRACI-XL.

This range is obtained due to the implementation of a condensing unit equipped with a Bitzer 2DC-3.F1Y Varispeed compressor andSWEP heat exchanger with a system performance as follows:

- at 30 Hz;  $Q_0 = 0.55$  kW,  $T_0 = -45^\circ$  C,  
 $T_{suction} = -30^\circ$  C,  $T_c = +35^\circ$  C,  $T_{sub} = 3$  K, R404a.
- at 87 Hz;  $Q_0 = 1.59$  kW,  $T_0 = -45^\circ$  C,  
 $T_{suction} = -30^\circ$  C,  $T_c = +35^\circ$  C,  $T_{sub} = 3$  K, R404a.

### System operation

A LEWA membrane pump with remote head design, as innovation to avoid the addition of residual heat in the

\* Supported by EU-FP7 CRISP.

coolant, transports sub-cooled CO<sub>2</sub> to the evaporator in the thermal box (1-2-3-4-5 in Fig. ??). The CO<sub>2</sub> is heated up to the right evaporation temperature by a heat ex-change produced inside an inner hose with the returning CO<sub>2</sub> line (6-7). Due to the pulses generated by the metering pump the installation of a pulsation dampener is needed.

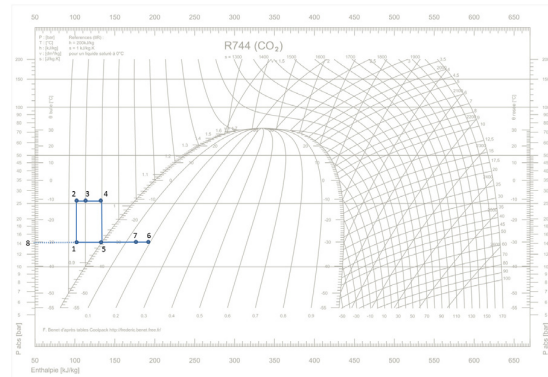


Figure 2: Cycle in Enthalpy-Pressure diagram for R744.

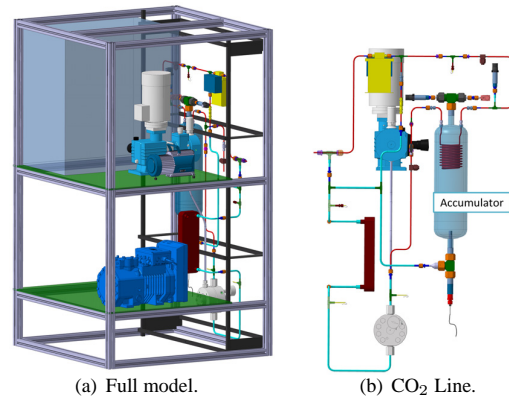


Figure 3: CAD model with CO<sub>2</sub> line detail.

The heat generated in the read-out electronics is absorbed and extracted by the evaporator capillaries inside the thermal box (5-6). The return line (8-1) contains a bi-phase mixture which is liquefied by the condensing unit named previously below the operating temperature. By controlling the pressure inside an accumulator the evaporation temperature can be fixed. This vessel contains two-phase CO<sub>2</sub> in contact (see Fig. ??).

### References

- [1] Verlaet, B., International Conference of Refrigeration 2007, Beijing, China, ICR07-B2-1565